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ABSTRACT

Specific limitations of past research in teacher verbal questioning behavior are presented in this article for the purpose of providing recommendations for future research activities. Analyses are made by reviewing related literature. Limitation factors are identified as resulting from variations in the following aspects: teacher characteristics, subject matter content, sampling techniques of teacher questioning behavior, dimensionality of question category systems, model instructional strategies, use of syntax in categorization of questions, and protocols for categorizing questions. Recommendations are made following the discussion of each limitation situation. For future investigation, the author points out three directions: development of science lessons which contain key questions, enhancement of prospective teacher awareness of the questioning techniques in instruction, and analysis of inservice teacher questioning behavior in terms of effective use of science programs. (CC)

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Limitations of Research in Science Teacher Questioning Behavior

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Limitations of Research in Science Teacher Questioning Behavior

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For the past 10 years there has been a renewed interest in one particular aspect of classroom interaction: teacher questioning behavior. The importance of this behavior has led educators to examine many of the variables related to the effectiveness of teacher questioning. Several reviews of the literature (Beisenherz, 1971; Clegg, 1971; Cunningham, 1968; Gall, 1971; Hoetker and Ahlbrand, 1969; Hunkins, 1968; Kondo, 1967; Snyder, 1966; and Tucker, 1971) have identified the major findings and short-comings of present research efforts.

This paper attempts to extract from these reviews of the literature specific limitations of past research in teacher questioning behavior and to provide recommendations for future research in this area.

The following limitations and recommendations appear warranted from an analysis of verbal questioning behavior of teachers during science instruction.

1. Importance of teacher variables on questioning behavior.

A. Age and Number of Years Teaching Experience: A number of researchers (Bruce, 1969; Haynes, 1935; Kleinman, 1965; Pate, 1969) have investigated the effect of these variables on questioning behavior. The conflicting findings make any interpretation difficult. One suspects that correlational studies involving these variables are often ancillary to the main purpose of the research effort. The importance of these variables in the development and implementation of curricular materials in the classroom is difficult to ascertain.

B. Science Background of the Teacher: A number of studies in elementary school science (Hardin, 1965; Hines, 1966; Olstad, 1959; Victor, 1961) have identified the lack of adequate science background to be a potential factor adversely influencing the teaching of elementary school science. However, in identifying specific teacher behaviors that might be affected by a teacher's educational background in science, e.g. questioning, the writers could find no studies to support this contention. Bruce (1969) and Kleinman (1965) for example, found no significant relationship between the number of hours of science in the teachers' academic background and their ability to engage in high level questioning, or any of the specific question types utilized in their studies.

These results are surprising. The writers would expect to observe a high relationship between the number and quality of questions asked by a teacher using the ESS unit, Batteries and Bulbs, for example, and his degree of conceptual understanding of the specific topics of electricity and magnetism involved in the lessons. Also, it would be expected that the teacher's questioning effectiveness would be improved upon prior training and increased trials of the unit with children.

One suspects that in studies examining this variable on teacher questioning behavior, adequate parameters were not established for the science content that teachers utilized in their lessons.

Recommendation: While interesting findings are sometimes obtained, the effect of the manipulation of teacher age, experience, and content background variables on the improvement of classroom questioning is vague at best.

2. Control of Subject Content.

A study by Gallagher, et al. (1966) attempted to control the subject-matter taught. Six teachers, using the Biological Sciences Curriculum Study

(BSCS) Blue Version, Molecules to Man, recorded on audio-tape each of the classes in their discussion sections for three consecutive days while teaching the subject of photosynthesis. From the analysis of the verbal behavior of teachers and students involved in the study, Gallagher (1967) concluded that:

> there is really no such thing as a BSCS curriculum presentation . . . . The substantial differences found in the teachers' verbal behavior in terms of goals and levels of abstraction suggest that the teachers have different approaches in terms of instructional strategy that result in different ideas and concepts being presented to students.

Although analysis of teacher questioning was not performed in this study, it illustrates the highly variable nature of teacher questioning behavior, within the same science content.

A basic problem in most studies in questioning in science involved the lack of adequate control of science content within which questions were asked. When the questioning behavior among groups of teachers was being compared, the lack of adequate delineation of science content made interpretation difficult, if not impossible. Gall (1971) stated that "If the researcher is studying differences between teachers in question-asking skill or is studying improvement in this skill as a result of a training program, the use of a constant lesson topic makes it possible to attribute variance in question asking to the teachers rather than to differences in the lessons."

Recommendation: Whenever possible, teachers or groups of teachers, should be compared on the basis of identical science content, e.g. identical lessons with identical objectives, activities, and instructional strategies.

3. Sampling of Teacher Questioning Behavior.

A related problem involves the sampling of lessons for analysis. Characteristic of most studies has been the lack of consideration for direct comparisons of specific content between teachers and groups, as well as the lack of control of the number of questions per teacher. These studies typically randomly select lessons for analysis from the total number of lessons observed by the researcher. The assumption that appears to be made in these studies is that teacher questioning behavior is unrelated to the subject-matter content and the context in which the questions are asked. Because of the highly variable nature of each teacher's questioning behavior, comparisons between treatment groups may be affected because of the large number of certain question types asked by particular teachers within a group. Recommendation: If sampling techniques are utilized in the selection of lessons to be analyzed, identical lessons should be selected for all teachers for all treatment groups. In addition, the number of questions sampled per teacher should be held constant.

4. Dimensionality of Category Systems Utilized.

What kinds of questions should teachers ask during science instruction? Existing taxonomies attempt to classify questions that encompass only a few of the stated goals of science instruction. Although a majority of studies in science questioning behavior have involved question categorization using the Bloom model or Guilford model, representative category systems have also been developed by Beisenherz (1971), Kleinman (1965), Fischler (1967-68), Suchman (1966), and Tucker (1971). With the exception of studies conducted by Beisenherz and Tucker, nearly all studies in science education have utilized uni-dimensional category systems, that is, the classification of a question

one time into a category pertaining to one dimension, e.g. level of thinking, process skill emphasis.

Recommendation: Gall, in expressing concern for the limiting nature of existing systems, offered the following recommendation:

> Prior to defining effective types of questions, the researcher needs to identify valued educational objectives in a specific setting. Once objectives are identified, the task of constructing questions which enable the student to reach each objective can be started. It would help in this task if groups of expert teachers and curriculum developers composed questions for each objective and then selected the most effective questions. In this type of research, effective question types would be defined in terms of whether or not they enabled the student to achieve desired educational objectives.

As these objectives often include more than one dimension, a multi-category system is often appropriate for research purposes. Hence, a question could be categorized as being divergent (Gallagher, 1965) soliciting hypotheses from the students (Tucker, 1971), and occurring during the exploration or application phase of a model instructional strategy (Beisenherz, 1971).

5. Use of Model Instructional Strategies.

In pursuing the issue of what questions teachers should ask, science educators seemed to value more highly "higher level" thinking questions. Gallagher (1965) raised an intriguing point when he suggested that the role played by teachers and pupils in phrasing factual, cognitive-memory questions, in addition to "productive thought" questions, was an essential one. He suggested that such questions must naturally exist in large numbers in order to allow the development of a broad base of information on which to act. He further stated that:

> ...(a) very respectable classroom (in terms of cognitive performance) can be operated without divergent thinking being requested at all. The same could not be said about cognitive-memory or convergent thinking responses.

The preceding suggests the importance of each of the components found in a category system such as the Bloom or Guilford model. It further implies a need to progress beyond the general question, "What is the effect of certain categorizations of teachers' questions on pupil behavior?" to such questions as, "Given a teaching strategy particular to a specific discipline, e.g. science, what kinds of questions are more appropriate at each phase of that strategy?"

This implies a weakness in current research in the analysis of questioning which Clegg (1971) clearly identified:

> Category systems such as those described (by Bloom (1956) and Gallagher (1965)) are useful for developing explanatory theory and for indicating the relatively low cognitive level of classroom operation. But to be of further use, prescriptive strategies must be developed (such as Taba has done) complete with eliciting questions which are designed to produce certain desired types of responses from students. Such theoretical strategies must then be validated by field testing to develop sufficient empirical evidence to support them. Otherwise, the untested theory degenerates to the present condition of hortative advice accompanied by little more than static, normative data.

Recommendation: If science educators can agree on one or more model instructional strategies that are consistent with learning theory and the nature of the scientific enterprise, formative and summative research and evaluation could be conducted on the development and implementation of science curricula containing such model question strategies.

6. Use of Syntax in the Categorization of Questions.

A problem encountered by question coders is the decision to classify each question on the basis of its syntax or its context within the lesson. Although syntactical structure has been commonly used as a basis for coding questions, uncertainties over question types develop when questions are judged out of context. For example, the question, "How many different ways can you make carbon dioxide?" might seem to be a divergent type of question. However,

when this question is asked during a review of the lesson in which ways of making carbon dioxide had previously been identified, it would be a simple recall type of question. In short, syntax alone is not sufficient in determining the classification of a question.

Recommendation: Whenever possible, questions should be categorized with consideration of the context in which the questions were asked. This suggests that the investigator and coders must be familiar with the lesson, the questions, their sequence and the context in which they were asked.

7. Protocals for Categorizing Questions.

The classification of questions into any system involves many difficult decisions concerning selection of the appropriate category. While some training manuals are available, most researchers are forced to establish their own set of protocols for question analysis. This practice seriously limits the comparability of their studies with others--even those utilizing the same category system(s).

Recommendation: A concerted effort should be made to identify category systems appropriate to the objectives of science instruction. Following this effort, training manuals should be developed and made available to the research community that contain complete coder training procedures, including an extensive set of protocols with sample questions. Also included should be suggestions and possible procedures for the determination of coder reliability.

8. Direction for Future Research.

Analysis of teacher questioning behavior in past research studies has largely involved comparisons of mean proportions of question types among treatment groups. While information has been obtained on the relative emphasis of questioning behavior within the constraints of a particular variable,

e.g. amount of training, type of program, the many teacher and student variables affecting concept development place a serious limitation on the importance of group data in the development of instructional strategies for the teaching of specific concepts.

One of the challenges to the educational researcher is to provide research that is meaningful for classroom teachers and administrators. Gall (1971) suggested that following the identification of desirable educational objectives for science instruction, future research must evolve that is based on the types of questions that teachers should ask. If, as Clegg suggested, prescriptive strategies must now be developed, it would appear that emphasis should be placed on individual teachers and the effectiveness of their questioning strategies with their students in the teaching of particular concepts. This strategy implies three directions for investigation:

a. Development and extensive trial testing of science lessons that contain key questions designed to achieve stated objectives and that are consistent with learning theory and the nature of science.

b. Development in the prospective teacher the awareness of the role of questioning in the achievement of specific science objectives. Work in the university and public school classroom with science lessons containing exemplary questioning strategies would provide needed awareness. Can such experiences be identified that will involve a possible change in questioning behavior that will transfer to a future teaching assignment?

c. In-service teacher education designed to train the teacher to more effectively implement the objectives and instructional strategies of the specific science materials and programs chosen by the school or the teacher. One measure of effectiveness would involve the analysis of his verbal questioning behavior.

Does such training result in more effective utilization of the science program? Does the possible change in questioning behavior resulting from the training transfer to other science units and to other subject areas?

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